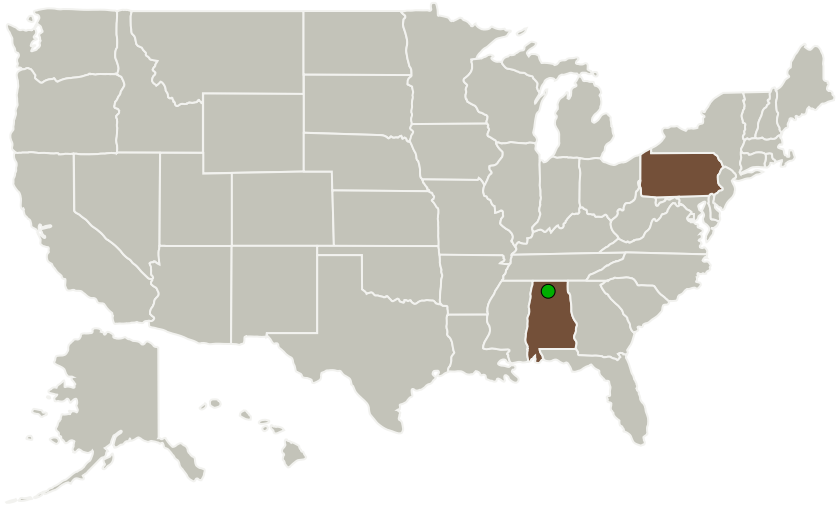
Modeling Turbulence Effects in Cryogenic Propellant Tank Thermal Management, Phase I

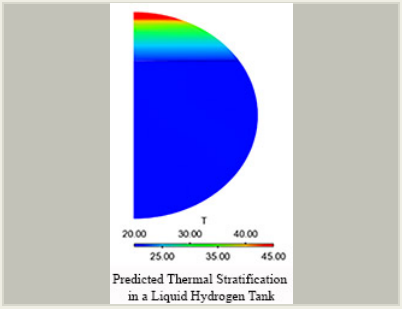
Completed Technology Project (2017 - 2017)

Project Introduction

Control and management of cryogenic propellant tank pressures in low gravity is an important technical challenge to overcome for future long duration space missions. Advanced techniques such as thermodynamic vent systems (TVS) are currently being designed for low-gravity space systems, and advanced computational tools are required to analyze the complex multi-phase physics involved. The proposed effort extends computational fluid dynamics capabilities to consider the behavior and effects of turbulence on heat/mass transfer at the tank gas/liquid interface and dispersed-phase droplet vaporization. Model extensions to fundamental kinetics-based mass transfer models are investigated for application to cryogenic systems. The methodology will be tested with the CRUNCH CFD code which incorporates real-fluid equations-of-state for cryogenic fluid mixtures with rigorous fluid property definitions, and an advanced dispersed phase spray model that permits non-equilibrium mass, drag, and heat transfer with the surrounding continuum fluid. The models improvements will be readily transferable to alternate codes and support unsteady RANS simulations in an Eulerian-based gas/liquid framework. This technology will support cryogenic system analysis for long duration space exploration activities.

Primary U.S. Work Locations and Key Partners





Modeling Turbulence Effects in Cryogenic Propellant Tank Thermal Management, Phase I Briefing Chart Image

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Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
CRAFT Tech - Combustion Research and Flow Technology	Lead Organization	Industry	Pipersville, Pennsylvania
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Transitions

June 2017: Project Start

December 2017: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140784)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CRAFT Tech - Combustion Research and Flow Technology

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

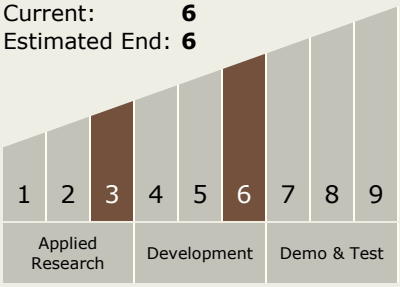
Carlos Torrez

Principal Investigator:

Kevin W Brinckman

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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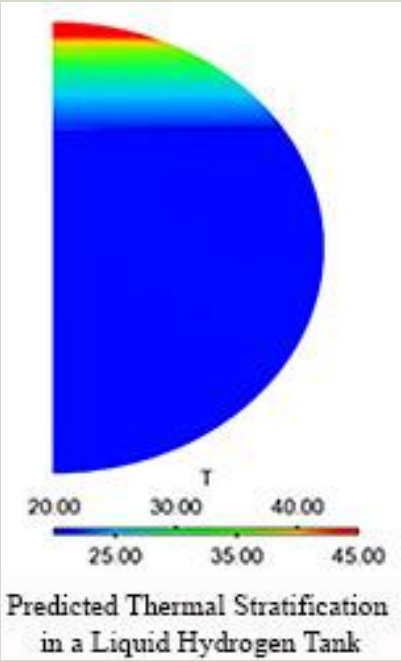
Images



Briefing Chart Image
Modeling Turbulence Effects in Cryogenic Propellant Tank Thermal Management, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/127444)

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.5 Cryogenic Analysis, Safety & Properties

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System